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AEROSPACE PAYLOAD DESIGN AND DEVELOPMENT

Richard B. Gates

Wentworth Institute of Technology Wentworth Laboratories 550 Huntington Avenue Boston, Mass 02115

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Final Report March 1988-May 1992

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1.0 INTRODUCTION

Summarized in this report is the work performed under contract F19628-88-C-0031 from March 24, 1988 into May 31, 1992. (An extension was granted on Modification P00082, April 29, 1992, making the period of work 50 months). Efforts consisted of design and fabrication of one-of-a-kind payloads and flight instruments, ground equipment, field launch services and refurbishment of recovered payloads and instruments.

1.1 PROGRAM SUMMARY

Wentworth's primary task accomplished under Contract F19628-88-C-0031 was to provide design, engineering and fabrication support for Phillips Laboratory toward the development of payloads for infrared measurements and other physical science experiments in space. Specific services provided included mechanical design and analysis of mechanical pieces and electro-mechanical devices, development of cost effective fabrication techniques, testing and field support of the hardware. Also provided were the design, fabrication, assembly, testing and integration of electronic devices including PCB's and their circuitry. Wentworth's long experience in payload support contributed to being a cost effective supplier of diverse services at close proximity to Phillips Laboratory. The results of this contract added to the existing success record and expertise of Wentworth and enabled us to win the succeeding contract with Phillips Laboratory, F19628-92-C-0096.

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2.0 PROJECTS

An overview of 28 projects that Wentworth participated in is presented in this section. Additional projects that Wentworth was involved in to a lesser degree are listed in 2.29. The format by which these projects are reviewed is as follows:

Title - Acronym or project name.

 - Digitized code number for project from AFGL or 3 digit projectnumber from WIT's Contract Reporting System.

Dates - Period of time during which work was performed by WIT.

Configuration/Mission - Launch vehicle, brief payload and mission description (when known).

Task Elements - Wentworth's level of effort in the project.

Summary - Results of Wentworth's efforts and launch date (if known).

2.1 SHAKE PLATE, BOOM/CAN (101,102) - July 1988 - September 1988

- 2.1.1 <u>Configuration/Mission</u> A 44" diameter Aries payload designed to produce neutral particle beams in space and study their interaction.
- 2.1.2 <u>Task Elements</u> Staff personnel designed a shake plate and supported the ground testing of the BEAR payload.
- 2.1.3 <u>Summary</u> TM/Physics can was successfully tested and integrated. Launch was successful July 13,1989.

2.2 EXCEDE III (120) July 1988 - March 1991

- 2.2.1 <u>Configuration/Mission</u> A 38" diameter Aries payload with an electron gun section and an instrument section.
- 2.2.2 <u>Task Elements</u> Design and subcontracting of Aries Launch Preparation Shelter at White Sands Missile northern range. Work continued after the EXCEDE III launch to modify the structure for various size rockets and different missions.
- 2.2.3 Summary EXCEDE III was successfully prepared and flown April 1991.

2.3 REFS. REFS 2 (121,123) - January 1990 - June 1992

- 2.3.1 <u>Configuration/Mission</u> Small 2.75" diameter rockets intended to determine the electrostatic field distribution prior to conventional attempts to trigger lightning with small rockets towing wires.
- 2.3.2 <u>Task Elements</u> Design and fabrication of several payloads containing electronics and batteries with an outer rotating shell.
- 2.3.3 <u>Summary</u> Many of the payloads built by Wentworth were successfully flown in the summers of 1990 1992.

2.4 <u>ULPS, ULPS II (122,676)</u> - October 1990 - March 1992

- 2.4.1 <u>Configuration/Mission</u> The Universal Launch Preparation Shelter was built to house the SPIRIT II and other launch preparations at Poker Flats, Alaska.
- 2.4.2 <u>Task Elements</u> Wentworth designed, analyzed and contracted out the construction of the horizontal shelter.
- 2.4.3 <u>Summary</u> Construction was completed on the structure and SPIRIT II was successfully launched.

2.5 <u>LLLTV, AIS, TRANSMITTER, CIV, GSE, VIBRATION, BAFFLE, SAUNDERS, CIV MODIFICATIONS (201,202,203,204,205,206,207,208,211)</u> -July 1988 - June 1991

- 2.5.1 <u>Configuration/Mission</u> Infrared Background Signature Survey (IBSS) was shuttle based experiment using a Shuttle Pallet Satellite as a space platform to make standoff measurements of infrared, ultraviolet and visible optical backgrounds and measurements. Other parts of the IBSS experiment remained in the Shuttle cargo bay to provide phenomenon for observation.
- 2.5.2 <u>Task Elements</u> Camera housings and baffles, electronic boxes, ground support equipment and test support were provided to AFGL.
- 2.5.3 <u>Summary</u> All equipment provided was flown and performed satisfactory on Discovery's Mission 39 in May 1991.

2.6 <u>VIPER (209)</u> October 1988 - December 1990

- 2.6.1 <u>Configuration/Mission</u> Visual Photometric Experiment (VIPER) is a Getaway Special Canister (GAScan) that flew in the cargo bay of the Shuttle. Its objective was to measure the diffuse zodiacal and galactic emissions at the B, R, and V standard astronomical wavelengths.
- 2.6.2 <u>Task Elements</u> Wentworth designed and fabricated all mechanical structures and devices for the internal support, electronic packaging, camera housings and filter drive wheel. Support electronics for the wheel, shutters, recorder and housekeeping were also designed and built.
- 2.6.3 Summary VIPER was successfully flown on STS 42 in January 1992.

2.7 LANGMUIR PROBE (401) - July 1988 - June 1990

- 2.7.1 <u>Configuration/Mission</u> These sensor probes are used on various upper atmospheric missions. The final use for the probes in this period is unknown.
- 2.7.2 <u>Task Elements</u> Staff personnel built seven electron density probes and their protective covers.
- 2.7.3 Summary Hardware was delivered on time and in cost.

2.8 POSITIONING TABLE (408) - April 1989 - December 1990

- 2.8.1 <u>Configuration/Mission</u> The testing of Electro-Static Analyzers must be done in a variety of positions in a vacuum. These ESA's are used on many different missions.
- 2.8.2 <u>Task Elements</u> Wentworth designed and built a four degree of freedom positioning table that can be used in a high vacuum chamber.
- 2.8.3 <u>Summary</u> Hardware was delivered on time and has proved to be successful as ground support testing.

2.9 CATHODE ASSY (409) - July 1989 - December 1990

- 2.9.1 <u>Configuration/Mission</u> Various experiments require the generation of a plasma while in the upper atmosphere.
- 2.9.2 <u>Task Elements</u> Wentworth re-engineered a plasma contactor from a NASA design.
- 2.9.3 Summary Hardware proved satisfactory in ground tests.

2.10 <u>3RD SCEX UNIT (411)</u> - October 1989 - September 1990

- 2.10.1 Configuration/Mission SCEX
- 2.10.2 <u>Task Elements</u> Wentworth built and packaged the components including power supplies, tri-quadraspherical collector and channeltrons in two Electro-static analyzers for SCEX. They were follow-ons to similar ESA's flown on ECHO-7 and therefore called "3rd".
- 2.10.3 Summary Hardware was delivered working and on time.

2.11 FARADAY CUP (412) - December 1989 - March 1990

- 2.11.1 Configuration/Mission Ground support and testing.
- 2.11.2 <u>Task Elements</u> Wentworth designed and built a "Faraday Cup" to aid in GL ion calibration system.
- 2.11.3 Summary Hardware was delivered on time.

2.12 LIFE (414) January 1990 - March 1991

2.12.1 Configuration/Mission LIFE

2.12.2 <u>Task Elements</u> Provide hardware support for the design, fabrication and testing of a guidance platform and parachute recovery system, preflight analysis and documentation for the guidance system and integration and launch operations support.

2.12.3 <u>Summary</u> Hardware for the guidance system and parachute recovery systems were provided. Program was canceled before integration and launch support was required.

2.13 POLAR GSE (415) - July 1990 - September 1991

- 2.13.1 Configuration/Mission POLAR
- 2.13.2 Task Elements Design and fabricate GSE cabling for the POLAR program.
- 2.13.3 Summary Cabling was delivered on time.

2.14 <u>LCLV/ROBIE (416)</u> - July 1990 - September 1990

- 2.14.1 <u>Configuration/Mission</u> Low Cost Launch Vehicle (LCLV)/ROBIE was a SDIO experiment intended to place a single diode electron beam system in the upper atmosphere along with twenty current robes and a gas ejection device.
- 2.14.2 <u>Task Elements</u> Design and build mechanical electron beam parts, blow away doors and gas release device, structures and support brackets, and current probe electronics box and relay unit support.
- 2.14.3 Su nary Parts were delivered on time. Flight was successfully flown in February 1991.

2.15 PASP PLUS/PASP PLUS III/PASP PLUS III (417,418,669) -January 1991 - June 1992

2.15.1 Configuration/Mission Photovoltaic Array Space Power Plus Diagnostics (PASP Plus) puts in space twelve advanced solar array designs and associated diagnostic instrumentation to test their operation in the space plasma environment.

2.15.2 Task Elements Wentworth provided engineering support for the design of the Langmuir probe and Sensor Potential (SENPOT) circuits. The actual Langmuir probe, flight qualified electronic components and electronic packaging were also provided.

2.15.3 Summary PASP Plus is scheduled for flight in late 1992.

2.16 DIGBE (501) - September 1988 - June 1989

- 2.16.1 <u>Configuration/Mission</u> A 21" diameter Aries payload with electro mechanical devices and infrared sensors designed to study interstellar clutter with a rotating out of line of flight sensor.
- 2.16.2 <u>Task Elements</u> Wentworth performed various electronics tests for continuity and functionality on the CVFS and other electro-mechanical devices and circuits in preparation for refurbishment.
- 2.16.3 Summary Funding was cut, preventing further work.

2.17 <u>COLDR II (502)</u> - September 1988 - March 1990

- 2.17.1 Configuration/Mission The efforts expended in the project titled Conductivity of the Lower D-Region (COLDR II) were to support two missions. COLDR II was a 12" 14" payload on top of Nike-Orion rocket. Micro-COLDR was a smaller payload on a Super Arcus rocket. Both projects intended to investigate the conductivity of the lower D-region by moving a mass spectrometer through the region by descending parachute.
- 2.17.2 <u>Task Elements</u> Wentworth supplied various mechanical parts for the parachute, pressure, despin and transition sections and electronic parts for the deployment guns, pressure monitoring instruments and connectors.
- 2.17.3 Summary Hardware was delivered on time and fully tested.

2.18 MASS SPEC, MASS SPEC II (504, 674) - September 1988 - March 1992

- 2.18.1 Configuration/Mission Unknown
- 2.18.2 <u>Task Elements</u> Electronic circuit boards, harnesses and mechanical housings typical of mass spectrometers were to be made.
- 2.18.3 Summary Parts were delivered on time.

2.19 ASC / TIPACT (505) - June 1990 - March 1992

- 2.19.1 <u>Configuration/Mission TIPACT</u> (Totally Integrated Payload Attitude Control Tester) is a device to test inertial guidance units for sounding rockets and replace less sophisticated one degree of freedom systems.
- 2.19.2 <u>Task Elements</u> Fabricate the mechanical parts for TIPACT, test samples of Kevlar straps.
- 2.19.3 <u>Summary</u> Parts delivered on time.

2.20 FLOW TUBE (506) - September 1990 - December 1990

- 2.20.1 Configuration/Mission Unknown
- 20.2 <u>Task Elements</u> Provide design and fabrication support for vacuum hardware for the High Temperature Flow Tube Experiment
- 2.20.3 <u>Summary</u> Engineering and fabrication support were provided on an as needed basis.

2.21 METEOR SCATTERING, CHEMICAL MODELING (651, 652)

-July 1988 - September 1990

- 2.21.1 Configuration/Mission Unknown
- 2.21.2 <u>Task Elements</u> Provide engineering support in the equilibrium composition and thermochemical properties for atmospheric wake species important in rocket plumes and re-entry phenomena.
- 2.21.3 Summary Studies were completed on time and in cost.

2.22 <u>CONCORD SCIENCES, CONCORD SCIENCES III</u> (653,663,709) - September 1988 - December 1990

- 2.22.1 Configuration/Mission Unknown
- 2.22.2 <u>Task Elements</u> In conjunction with Concord Sciences, Wentworth provided engineering services in the areas of equilibrium computer analyses, non-equilibrium model computations of flowfield elements, full-scale and simulated hypersonic flight measurements, all of which supported the development of hypersonic flowfield chemistry.
- 2.22.3 Summary Analyses and reports provided to the satisfaction of AFGL.

2.23 YORK (654) - January 1989 - September 1990

- 2.23.1 Configuration/Mission Unknown
- 2.23.2 <u>Task Elements</u> In conjunction with York University, Wentworth provided engineering services for methods to add chemicals to plasmas to decrease ion and free electrons and their associated measurements.
- 2.23.3 Summary Analyses and reports provided to the satisfaction of AFGL.

2.24 <u>SANDIA (656)</u> - April 1989 - March 1991

- 2.24.1 Configuration/Mission Unknown
- 2.24.2 <u>Task Elements</u> Wentworth to provide design, fabrication and testing support for mechanisms to inject chemicals into a flow field.
- 2.24.3 <u>Summary</u> Support was provided until the project was canceled preventing final results.

2.25 SpaDVOS (657) - July 1989 - June 1990

- 2.25.1 Configuration/Mission The Spaceborne Direct-View Optical System (SpaDVOS) was a folded-optical path telescope system which mounted inside the Shuttle's over-head cabin window to permit real time direct view observation of terrestrial ground sites from the Shuttle orbiter. This project was to be a study of a second generation system.
- 2.25.2 <u>Task Elements</u> Wentworth, in conjunction with SSG,Inc., provided a engineering design of an improved SpaDVOS with optical performance parameters and ergonomic factors.
- 2.25.3 Summary The design was provided to AFGL.

2.26 <u>WAKE/RAM EXPERIMENT, WAKE RAM II, CHAW II, CHAW III (659, 664, 675, 677, 678)</u>

- January 1990 March 1992
- 2.26.1 <u>Configuration/Mission</u> The Wake/Ram or CHAWS Program (Charge and Wake Studies) is a shuttle free flier that will generate an extremely high vacuum in order to create ultra-pure thin films in space.
- 2.26.2 <u>Task Elements</u> Wentworth designed and built the wake plasma sensor that will be flown on the outer perimeter of the 12 foot shield.
- 2.26.3 <u>Summary</u> Hardware was delivered on time. The University of Houston's Wake Shield Facility will fly on the shuttle in mid-1993.

2.27 <u>JOHN WILLIAMSON, II WILLIAMSON, III WILLIAMSON (661, 665, 671)</u> - July 1990 - May 1992

- 2.27.1 Configuration/Mission Selected Ion Flow Drift Tube
- 2.27.2 <u>Task Elements</u> Design and build the upgrade for the High Temperature Ion Source Apparatus, provided engineering support for the SIFDT apparatus.
- 2.27.3 <u>Summary</u> Work is on going to maintain and update the equipment with higher temperature capabilities.

2.28 PAUL MUNDIS, II MUNDIS, III MUNDIS (662, 667, 672) - July 1990 - May 1992

- 2.28.1 Configuration/Mission High Temperature Flowing Afterglow
- 2.28.2 <u>Task Elements</u> Perform electronic design and fabrication of the HTFA and SIFDT.
- 2.28.3 Summary Work was done on time.

2.29 Lesser Projects

Wentworth participated in a lesser manner in some projects by supplying hardware or services to AFGL (Phillips Laboratory). Our effort was not enough to be able to fully identify the extent of our participation or claim a full part in the project. Consequently, these projects are just listed below:

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668

3.0 **PERSONNEL** The value of experience should not be undervalued when rating an organization's capability to provide quality aerospace hardware and services at cost effective rates. The following individuals contributed to the projects as outlined in this report.

<u>Name</u>	Title	Years at WIT	Total Exper. Years	Education
Benassi, Howard	Spvr, Manuf.	4	34	AS
Brisebois, Normand	Machinist	1	1	AS
Butler, Thomas	Machinist	2	2	BS
Cabral, Rudolph	Instr Maker	13	24	Cert.
Fritzler, Frederic	Instr Maker	40	40	Cert.
Gagnon, Jeffery	Machinist	1	1	BS
Gambale, Alfonso	Instr Maker	19	19	Cert.
Gideon, Saul	Machinist	1	1	AS
Larson, Jon	Mstr Mdl Mkr	7	7	BS
Reid, Matthew	Machinist	1	1	BS
Sharpe, Donald	Machinist	2	2	BS
Schavrien, William	Machinist	2	2	Cert.
Silva, Joeseph	Instr Makr	6	30	AS
Theodore, Erwin	Exper Mach	25	32	As
Campbell, Thomas	Spvr, Elect.	23	23	BS
Cutter, George	EEng Tech V	30	30	BS
Dimilla, Thomas	EEng Tech V	34	34	AS
Mundis, Paul	EEng Tech V	27	44	AS
Nardella, Daniel	EEng Tech V	32	32	AS
Newell, Shawn	EEng Tech IV	5	5	BS
Rodrigues, Timothy	Elect Eng	5	5	BS
Smart, Lawrence	EEng Tech V	25	25	AS
LeBlanc, Edgar	Spvr, Mech	41	41	AS
Hartnett, Paul	Mech Eng Des	32	32	AS
Hurley, Patrick	Mech Eng Des	13	32	AS
Labelle, Paige	Mech Eng Coop	1	1	AS
Lund, Raynor	Mech Eng Des	8	27	AS
Murphy, Matthew	Mech Eng Des	5	10	BS
Gates, Richard	PI/Mech Eng	7	23	BS
Crawford, Angela	Secretary	1	1	AS
Deakyne, Carol	Chemist	4	14	PhD
De Hart, Donald	EEng Tech IV	3	20	AS
Joseph, June	Assist PI	12	15	Cert.
Rourke, Peter	Manuf Eng	10	15	BS

4.0 CHARTS AND GRAPHS

4.1 ACTIVITY BY QUARTER

The following chart is provided to allow tracking of Wentworth's activities on specific projects by quarter.

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209 VIPER 210 L.C. MISC. 211 CV WOOFFCATIONS 212 GROUND BASE 401 LANGNUIR PROBE 402 BILL SULLIVAN BOX 403 ANALYTYX REWORK 404 BL SULLIVAN BOX 405 E.S.A. 406 E.S.A. 407 P.C. BOARD 408 POSITIONING TABLE 409 CATHODE ASSY 409 CATHODE ASSY 410 HUCHES ORAWING 411 JRO SCEX UNIT 411 JRO SCEX UNIT 412 FARRADAY CUP 413 AMPTEX 414 UFE 415 POLAR GSE 416 LCLV 417 PASP PLUS 418 PASP PLUS 418 PASP PLUS 501 DICBE 502 "COLDR II" 501 DICBE 503 ABLE 70 V V V V V V V V V V V V V V V V V V V			1				L	├-	<u> </u>	┡	L	 	┝	L	ļ.,	L	╀-	١.,
210 L.C. MISC. 211 CIV MODIFICATIONS 212 CROUND BASE 401 LANGMUIR PROBE 402 BILL SULLIVAN BOX 403 ANALYTYX REWORK 404 ANALYTYX REWORK 405 E.S.A. 407 P.C. BOARD 408 POSITIONING TABLE 409 CATHODE ASSY 410 HUGHES DRAWING 411 AND SCEX UNIT 412 FARRADAY CUP 413 AMPTEX 414 UFE 415 POLAR GSE 416 LCLV 417 PASP PLUS 418 PASP PLUS 418 PASP PLUS II 501 DIGBE 502 "COLUR II" 501 DIGBE 502 "COLUR II" 503 ABLE 504 MASS SPEC. 505 ASC / TIPACT 506 FLOW TUBE 507 HUNTON 551 METEOR SCATTERING 552 "COLUR II" 553 CONCORD SCIENCES 554 YORK 555 GSO SUPPLES 556 SANDIA 657 SPADVOS 658 GRYOGENIC HOUSING 659 DANG ENDERS 651 METEOR SCATTERING 652 PAUL MUNDIS 653 CONCORD SCIENCES 654 YORK 657 SPADVOS 658 GRYOGENIC HOUSING 659 MAKE AND III 669 PASP PLUS III 667 III WILLIAMSON 667 III WILLIAMSO			↓_						١.,	١.	L	Ļ	⊢	-	Ļ	<u> </u>		Н
211			╀	۲	ľ	~					Ľ	~	╀	├-	۲	ļ.,	-	Н
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401 LANGNUIR PROBE 402 BILL SULLIVAN BOX 403 ANALYTYX REWORK 404 CATHODE ASSY 407 P.C. BOARD 408 POSITIONING TABLE 409 CATHODE ASSY 410 HUGHES DRAMMG 411 JRO SCEX UNIT 412 FARRADAY CUP 413 AMPTEX 414 LIFE 415 POLAR GSE 416 LCLV 417 PASP PLUS 418 PASP PLUS 418 PASP PLUS 418 DASP PLUS 419 DIGBE 502 COLDR II 501 DIGBE 502 COLDR II 503 ABLE 504 MASS SPEC 505 ASC / TIPACT 505 ASC / TIPACT 506 FLOW TUBE 507 HUNTON 551 METEOR SCATTERING 507 V V V V V V V V V V V V V V V V V V V			╀	├	-	-	┝	.				⊢	⊢	۲	┝	-	┝	Н
402 BILL SULLIVAN BOX 403 ANALYTYX REWORK 406 E.S.A. 407 P.C. BOARD 408 E.S.A. 407 P.C. BOARD 408 E.S.A. 409 CATHONE ASSY 410 HUGHES ORAMING 411 JRO SCCX UNIT 412 FARRADAY CUP 413 AMPTEX 414 UFE 415 POLAR GSE 416 LCLV 417 PASP PLUS 418 PASP PLUS II 501 DIGBE 502 "COLDR II" 503 ABLE 504 MASS SPEC. 505 ASC / TIPACT 506 FLOW TUBE 507 HUNTON 551 METEOR SCATTERING 552 CHEMICAL MODELING 554 YORK 555 BSO SUPPLIES 556 SANDIA 557 SPADVOS 658 CRYOGENIC MOUSING 659 WAKE /RAM EXPERIMENT 656 ESA-SPEAR 657 MANNISS 658 SURFACE POTENTIAL MON 659 PASP PLUS III 671 III MUNDIS 672 III MUNDIS 673 WAKE SHIELD 674 MASS SPEC. II V V V V V V V V V V V V V V V V V V		LANCHUS ASC	₽	1	┝	-	₽	5	_		۲	U	┪	-	┝	-	├	Н
403 ANALYTY REWORK 408 E.S.A. 407 P.C. BOARD 408 POSITIONING TABLE 409 CATHODE ASSY 410 HUGHES DRAMMIG 411 JRD SCEX UNIT 412 FARRADAY CUP 413 AMPTEX 414 UFE 415 POLAR GSE 416 LCLV 417 PASP PLUS 418 PASP PLUS II 501 DIGBE 502 **COLOR II** 502 **COLOR II** 503 ABLE 504 MASS SPEC. 505 FLOW TUBE 507 HUNTON 508 FLOW TUBE 507 HUNTON 651 METEOR SCATTERING 652 CAMMICAL MODELING 553 CONCORD SCIENCES 554 YORK 655 SANDIA 557 SPADVOS 658 SANDIA 657 SPADVOS 658 UV V V V V V V V V V V V V V V V V V V		ON CHILIVAN BOY			-	Н	۴	۲	-	۲	H	Ť	-	1	H	-	⊢	Н
407 P.C. BOARD 407 P.C. BOARD 408 POSITIONING TABLE 409 CATHOOE ASSY 410 HUGHES DRAMMG 411 JRO SCEX UNIT 412 FARRADAY CUP 413 AMPTEX 414 UFE 415 POLAR GSE 416 LCLV 417 PASP PLUS 416 LCLV 417 PASP PLUS 418 PASP PLUS II 501 DIGBE 502 "COLDR II" 501 DIGBE 502 "COLDR II" 503 ABLE V V V V V V V V V V V V V V V V V V V		ANALYTY SEWORK		۲	₩	v	t	-	⊢	+	H	+	-	\vdash	┢	۲	-	Н
407 P.C. BOARD 408 POSITIONING TABLE 409 CATHODE ASSY 410 HUGHES DRAMMG 411 JRO SCEX UNIT 412 FARRADAY CUP 413 AMPTEX 414 UFE 415 POLAR GSE 416 LCLY 417 PASP PLUS 418 PASP PLUS II 500 TOLOR II Y Y Y Y Y Y Y Y Y Y Y Y Y Y Y Y Y Y			ť	+	۲	-	_	~	┝	+-	Н	-	-	-	H	H	-	Н
408 POSITIONING TABLE 409 CATHODE ASSY 410 HUGHES DRAWNG 411 370 SCEX UNIT 412 FARRADAY CUP 413 AMPTEX 414 UFE 415 POLAR GSE 416 LCLV 417 PASP PLUS 416 PASP PLUS 417 PASP PLUS 418 PASP PLUS 501 DIGBE 502 **COLOR II** 502 **COLOR II** 503 ABLE 504 MASS SPEC. 505 ABLE 507 HUNTON 508 FLOW TUBE 507 HUNTON 508 FLOW TUBE 507 HUNTON 508 SCATTERING 508 SANDIA 509 ASC / TIPACT 508 SEC / V V V V V V V V V V V V V V V V V V			╁	┪	╆	Ť	_	┝	-	┰	₽	-	-	-	┝	Н	-	-
409 CATHODE ASSY 410 HUGHES DRAMMG 411 JRO SCEX UNIT 412 FARRADAY CUP 413 AMPTEX 414 UFE 415 POLAR GSE 416 LCLV 417 PASP PLUS II 501 DIGBE 502 "COLDR II" 503 ABLE 504 MASS SPEC. 503 ASC / TIPACT 506 FLOW TUBE 507 HUNTON 651 METEOR SCATTERING 652 CHEMICAL MODELING 653 CONCORD SCIENCES 654 YORK 655 SANDIA 657 SPADVOS 658 CRYOGENIC HOUSING 659 WAKE /RAM II 665 PLAW HULLAMSON 667 II MUNDIS 668 SUFFACE POTENTIAL MON 667 MASS SPEC. II 676 WAKE SHIELD 677 HUNDIS 677 HUNDIS 667 CONCORD SCIENCES II 668 SUFFACE POTENTIAL MON 669 PASP PLUS II 671 HIMILIAMSON 672 III MUNDIS 673 WAKE SHIELD 676 ULPS II 677 CHAW II 677 CHAW II			t	-	+-	V	_	-	-	1	_	-	\vdash	-	H	۲	-	Н
410 HUGHES DRAWNG 411 JRO SCEX UNIT 412 FARRADAY CUP 413 AMPTEX 414 UFE 415 POLAR GSE 416 LCLV 417 PASP PLUS 418 PASP PLUS 418 PASP PLUS 419 TO SCE 501 DIGBE 502 "COLDR II" 503 ABLE 504 MASS SPEC. 503 ABLE 504 MASS SPEC. 505 ABLE 507 HUNTON 508 FLOW TUBE 507 HUNTON 501 METEOR SCATTERING 507 HUNTON 508 SAD JABE 509 CHEMICAL MODELING 501 CONCORD SCIENCES 501 WY V V V V V V V V V V V V V V V V V V			t	1	✝	Ė						V	-	-	r	-	H	H
411 JRO SCEX UNIT 412 FARRADAY CUP 413 AMPTEK 414 UFE 415 POLAR GSE 416 LCLV 417 PASP PLUS 418 PASP PLUS II 501 DIGBE 502 "COLDR II" 502 "COLDR II" 503 ABLE 504 MASS SPEC 505 ASC / TIPACT 506 FLOW TUBE 507 HUNTON 508 FLOW TUBE 507 HUNTON 658 CHEMICAL MODELING 650 CHEMICAL MODELING 651 WELL 655 SANDIA 657 SPADVOS 658 CANORD SCIENCES 659 WAKE/RAM EXPERIMENT 660 ESA-SPEAR 651 MUNDIS 652 WAKE RAM II 653 WAKE SHIELD 671 III MUNDIS 672 III MUNDIS 673 MANS SPEC.			t	1	-				۲	Ť	۳	Ť	-	-	-	Н	\vdash	Н
412 FARRADAY CUP 413 AMPTEX 414 LIFE 415 POLAR GSE 416 LCLV 418 PASP PLUS 417 PASP PLUS 418 PASP PLUS II 501 DIGBE 502 "COLDR II" 502 "COLDR II" 503 ABLE 7 V V V V V V V V V V V V V V V V V V V			t-	1	\vdash	Н	_	-	7	V	⊽	-	_	П	┝	-	-	Н
413 AMPTEX 414 UFE 415 POLAR CSE 416 LCLV 417 PASP PLUS II 501 DICBE 502 "COLDR II" 503 ABLE 504 MASS SPEC. 503 ASC / TIPACT 506 FLOW TUBE 507 HUNTON 651 METEOR SCATTERING 652 CHEMICAL MODELING 653 CONCORD SCIENCES 554 YORK 655 650 SUPPLUES 656 SANDIA 657 YORK 658 CRYOGENIC HOUSING 659 WAKE / RAM EXPERIMENT 660 ESA-SPEAR 661 JOHN MILLIAMSON 662 PAUL MUNDIS 663 CONCORD SCIENCES II 664 WASS RAM II 665 II WILLIAMSON 667 II MUNDIS 676 ULPS II 677 WAKE SHIELD 677 WAKE SHIELD 676 ULPS II 677 WAKE SHIELD 677 WAKE SHIELD 677 CHAW II 677 CHAW II 677 CHAW II			 	-	 	Н	Н				Ė	-	-	-	-	\vdash	H	Н
414 UFE 415 POLAR GSE 416 LCLY 417 PASP PLUS 418 PASP PLUS II 501 DIGBE 502 "COLDR II" V V V V V V V V V V V V V V V V V V V			H	-	-	Н	Г	-			۲	-	-	-	l	-	-	H
415 POLAR GSE 416 LCLV 417 PASP PLUS 418 PASP PLUS II 501 DIGRE 502 "COLDR II" 503 ABLE 504 MASS SPEC. 505 ASC / TIPACT 506 FLOW TUBE 507 HUNTON 651 METEOR SCATTERING 652 CHEMICAL MODELING 505 ASC SANDIA 655 SANDIA 657 SPADVOS 658 CRYOGENIC HOUSING 659 WAKE/RAM EXPERIMENT 650 ESA-SPEAR 661 JOHN WILLIAMSON 662 PAUL MUNDIS 665 I WELLIAMSON 665 I MULIAMSON 667 II MUNDIS 667 II MUNDIS 667 WAKE SHIELD 676 U.P S II 677 CHAW II 677 CHAW II				-	-		Н		÷	Н	-	-	V	-	-	Н	Н	Н
416 LCLY 417 PASP PLUS II 501 DIGBE 502 "COLDR II" 503 ABLE 504 MASS SPEC. 505 ASC / TIPACT 506 FLOW TUBE 507 HUNTON 531 METEOR SCATTERING 507 HUNTON 531 METEOR SCATTERING 508 CONCORD SCIENCES 509 CONCORD SCIENCES 509 WAKE/RAM EXPERIMENT 509 WAKE/RAM EXPERIMENT 500 ESA-SPEAR 501 CONCORD SCIENCES 502 WAY V V V V V V V V V V V V V V V V V V V			Н	_	-		┍	Т	Ė		V	V	V	V	b		-	
417 PASP PLUS			Н	Н		Н	Н	-			V	Ť		Ė	۲		H	
418 PASP PLUS II 501 DIGBE V V V V V V V V V V V V V V V V V V V		PASP PLUS	г		Н	Н	Г		Г	Н	۲	_	V	Т	1	Т	V	V
SOI DICBE			1	-	_		Н	Н	Н	-	r	_		V	H	-	-	H
SO2 "COLDR II"			1	V	V	V	┪		Т	Г	┪	-		-	Н		-	
503 ABLE			Г				>	V	⊽		Г	_			_	_		
504 MASS SPEC.	503			V		V	>	V	Γ		Г	_			Г		\vdash	
SOS ASC		MASS SPEC.	П	V			V	V	7	V	V	V	V	V	V	Т	V	П
507 HUNTON		ASC / TIPACT								V	V	V	V		V	V	V	
507 HUNTON	506	FLOW TUBE										Y					\Box	
652 CHEMICAL MODELING	507	HUNTON											Y					
652 CHEMICAL MODELING	651	METEOR SCATTERING	٧	V	~	٧	×	V	٧									
S54 YORK	652	CHEMICAL MODELING			Y				V	٧	>							
655 650 SUPPLES				V				V										
656 SANDIA					•	╝	⊻.				\Box						V	
657 SPADVOS			Ш	~	V	_	_					Ц		Y				
658 CRYOGENIC MOUSING			Ш								Ľ	×	V					
659 WAKE/RAM EXPERIMENT			Ш			_	Y				Ц	Ц	Ц					_
560 ESA-SPEAR	$\overline{}$		Ш	_		_	Ц	Y		Market	***	_					✓	_
861 JOHN WILLIAMSON			Ш						Z	_	⊻	_	V	⊻	\mathbf{Z}	_		
662 PAUL MUNDIS			Ш	┙		_				⊻	Ш	_					J	
663 CONCORD SCIENCES			Ш	_	Ц	_	_	ا		Ц				_	Ш	_		
554 WAKE RAM			Ш	_	_	4	_	ل	_	Ц			V		Ш	_		_
685 II WILLIAMSON			Ц	_	_	_	_	J	_	_	Ц	_		_			\Box	_
687 II MUNDIS			4	_	_	4	Ц	_	_	Ц		~	_	_		_	_	_
688 SURFACE POTENTIAL MON			Н	4	4	4	4	4	_	Ц	Ц	_		_		_	_	4
669 PASP PLUS III			_	4	4	4	4	4	_	_	4	4	-	¥	Y	_	_	_
671 III MILLIAMSON 672 III MUNDIS 673 MASS SPEC. II 675 WAKE SHIELD 676 ULPS II 677 CHAW II 678 CHAW II			4	4	4	4	4	4	4	-4	4	_	_	∠	Ц	_	_	_
672 III MUNDIS 674 MASS SPEC. II 675 WAKE SHIELD 676 ULPS II 677 CHAW II 678 CHAW II			4	-	4	4	4	4	4	_	4		_				_	4
674 MASS SPEC. II V V V 675 WAKE SHIELD V V V 676 ULPS II V V V 677 CHAW II			4		4	4	4	4	-	- 4	-	-	_					
675 WAKE SHIELD V V C 676 ULPS II V V C 677 CHAW II C 678 CHAW III			4	4	-	-1	4	4	4	4	4	4	_					7
676 ULPS II V V 677 CHAW II 878 CHAW III			4	4	-	4	4	4	4	4	4	-	_	4				4
677 CHAW II 678 CHAW III			4	4	4	4	+	4	4	4	+	4	4	4				_
678 CHAW III			4	-	4	4	4	4	4	_	4	4	4	4	4	× 1	Y,	4
			4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
709 CONCORD SCIENCES III			+	4	4	4	+	4	4	4	4	4	4	4	4	4	4	4
	709	CONCORD SCIENCES III	i		-1	_1	_	1	_		_1			_		_	_	

Table 1 Activity by Quarter

ACTIVITIES UNDER F19628-88 · C--0031 BY QUARTER

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5.0 SELECTED DATA BASES

5.1 PERSONNEL BY MONTH

The following data is a listing by month of the personnel who worked on the contract. The numbers in the month columns are the WIT employee ID numbers.

L288.DOC	၁၀							
1988								
DEC	NOV	OCT	SEP	AUG	JUL		NOC	
1083	1083	1083	1083	1083	1083	BENASSI, HOWARD	1995	BENASSI, HOWARD
1169	1169	1169	1169	1169	1169	CAMPBELL, THOMAS	2490	CABRAL, RUDOLPH
1269	1269	1269	1269	1269	1269	CUTTER, GEORGE	2534	CAMPBELL, THOMAS
1285	1285	1285	1285	1285	1285	DEAKYNE, CARROL	3249	CUTTER, GEORGE
1289	1289	1289	1289	1289	1289	DE HART, DONALD	3458	DIMILLA, THOMAS
1315	1315	1315	1315	1315	1315	DIMILLA, THOMAS	4041	FRITZLER, FREDERIC
			1405	1405	1405	SILVA, JOSEPH	4107	GAMBALE, ALFONSO
	1422	1422	1422	1422	1422	FRITZLER, FREDERIC	4146	GATES RICHARD
1435	1435	1435	1435	1435	1435	GAMBALE, ALFONSO	4514	HARTNETT, PAU
1441	1441	1441	1441	1441	1441	GATES, RICHARD	4745	HURLEY, PATRICK
1447	1447	1447	1447	1447		LARSON, JON	4976	JOSEPH, JUNE
1509	1509	1509	1509	1509	1509	HARTNETT, PAUL	5405	LEBLANC, EDGAR
1		1545	1545	1545	1545	HURLEY, PATRICK	5668	LUND RAYNOR
•	1573	1573	1573	1573	1573	JOSEPH, JUNE	5978	MC.NEIL, CHRISTOPHER
1665	1665	1665	1665	1665	1665	LEBLANC, EDGAR	6286	MUNDIS, PAUL
1700	1700	1700	1700	1700	1700	LUND, RAYNOR	6318	NARDELLA, DANIEL
		1778	1778		1778	MC.NEIL, CHRISTOPHER	7285	RODRIGUEZ, TIMOTHY
1850						MURPHY, MATHEW	8111	THEODORE, ERWIN
	1846	1846	1846	1846	1846	MUNDIS, PAUL	8802	DE HART, DONALD
1859	1859	1859	1859	1859	1859	NARDELLA, DANIEL	8807	DEAKYNE, CARROL
1992						REID, MATTHEW		
	2020	2020	2020	2020	2020	RODRIGUEZ, TIMOTHY		
					2029	ROURKE, PETER		
2065						SHARPE, DONALD		
2110	2110	2110	2110	2110	2110	SMART, LAWRENCE		
					2185	THEODORE, ERWIN		
					2490	CABRAL, RUDOLPH		

		BENASSI, HOWARD	CAMPBELL, THOMAS	CUTTER, GEORGE	DEAKYNE, CARROL	DE HART, DONALD	DIMILLA, THOMAS	BRISIBOIS, NORMAND	SILVA, JOSEPH	GAMBALE, ALFONSO	GATES, RICHARD	LARSON, JON	HARTNETT, PAUL	HURLEY, PATRICK	JOSEPH, JUNE	LEBLANC, EDGAR	LUND, RAYNOR	MUNDIS, PAUL	MURPHY, MATTHEW	NARDELLA, DANIEL	RODRIGUEZ, TIMOTHY	SHARPE, DONALD	REID, MATTHEW	SMART, LAWRENCE	CRAWFORD, ANGELA	BUTLER, TOM	THEODORE, ERWIN
	JAN	1083	1169	1269	1285	1289				1435	1441	1447	1509		1573	1665	1700	1846	1850	1859	2020	2065	2092	2110		2147	
	FEB		1169	1269	1285	1289	1315			1435	1441		1509		1573	1665	1700	1846		1859	2020			2110		2147	
	MAR		1169	1269	1285	1289	1315			1435	1441	1447	1509	1545	1573	1665	1700	1846	1850	1859	2020	2065		2110			
	APR	1083	1169	1269	1285	1289		1317		1435	1441		1509		1573	1665	1700	1846	1850	1859	2020			2110			
	MAY	1083	1169	1269	1285	1289	1315	1317		1435	1441	1447	1509	1545	1573	1665	1700	1846		1859	2020			2110	2122	2147	2185
L189.DOC 1989	S S	1083	1169	1269	1285	1289	1315	1317	1405	1435	1441	1447	1509	1545	1573	1665	1700	1846		1859	2020		2092	2110	2122	2147	2185

			BENASSI, HOWARD	CAMPBELL, THOMAS	CUTTER, GEORGE	DEAKYNE, CARROL	DE HART, DONALD	DIMILLA, THOMAS	SILVA, JOSEPH	FRITZLER, FREDERIC	GAMBALE. ALFONSO	GATES, RICHARD	LARSON, JON	HARTNETT, PAUL	HURLEY, PATRICK	JOSEPH, JUNE	LEBLANC, EDGAR	LUND, RAYNOR	MUNDIS, PAUL	MURPHY, MATTHEW	NARDELLA, DANIEL	RODRIGUEZ, TIMOTHY	REID, MATTHEW	SMART, LAWRENCE	THEODORE, ERWIN
		JUL	1083	1169	1269	1285	1289	1315	1405		1435	1441	1447	1509	1545	1573	1665	1700	1846	1850	1859	2020	2092	2110	2185
		AUG	1083	1169	1269	1285	1289	1315	1405	1422	1435	1441	1447	1509	1545	1573	1665	1700	1846	1850	1859	2020	2092	2110	
		SEP	1083	1169	1269	1285	1289	1315	1405	1422	1435	1441	1447	1509	1545	1573	1665	1700	1846	1850	1859	2020	2092	2110	
		OCT	1083	1169	1269	1285	1289	1315	1405		1435	1441	1447	1509	1445	1573	1665	1700	1846		1859	2020	2092		
ပ္	o	NOV	1083	1169	1269	1285	1289	1315	1405		1435	1441	1447	1509	1545	1573	1665	1700	1846		1859	2020	2092	2110	
L289.DOC	1989	DEC	1083	1169	1269	1285	1289	1315	1405	•	1435	•	1447	1509	1545	1573	1665	1700	1846		1859	2020	2092	2110	
													IJ												

		Z	B3 BENASSI, HOWARD	CAMPBELL, THOMAS	269 CUTTER, GEORGE	1285 DEAKYNE, CARROL	39 DE HART, DONALD	15 DIMILLA, THOMAS	35 SILVA, JOSEPH	1435 GAMBALE, ALFONSO	41 GATES, RICHARD	47 LARSON, JON	DB HARTNET, PAUL	1545 HURLEY, PATRICK	•	35 LEBLANC, EDGAR	DO LUND. RAYNOR	46 MUNDIS, PAUL	MURPHY, MATTHEW	59 NARDELLA, DANIEL	SMART, LAWRENCE	A7 DITLED TUOMAS
		JAN	1083		12	12	1289	1315	1405	14.	1441	1447	1509	15	1573	1665	1700	1846		1859		7117
		FEB	1083		1269	1285		1315		1435	1441	1447		1545	1573	1665	1700	1846	1850	1859		74.47
		MAR	1083	1169	1269	1285		1315	1405	1435	1441	1447	1509	1545	1573	1665	1700			1859	2110	24.47
		APR	1083	1169	1269	1285		1315	1405	1435	1441	1447	1509	1545	1573	1665	1700		1850	1859	2110	2117
ပ္က	0	MAY	1083	1169		1285			1405	1435	1441	1447	1509	1545	1573	1665			1850	1859	2110	21.47
L190.DOC	1990	N S S	1083	1169		1285			1405	1435	1441	1447	1509	1545	⁶ 1573	1665				1859	2110	7447

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1990	? o					
SEC	NOV	OCT	SEP	AUG	JU.	
1083	1083	1083	1083	1083	1083	BENASSI, HOWARD
103	1103	1130	1130	1130		WILLIAMSON, JOHN
		1169		1169	1169	CAMPBELL, THOMAS
				1285	1285	DEAKYNE, CARROL
1404	1405	1405	1405	1405	1405	SILVA, JOSEPH
	1422	1422	1422	1422	1422	FRITZLER, FREDERIC
435	1435	1435	1435	1435	1435	GAMBALE. ALFONSO
441	1441	1441	1441	1441	1441	GATES, RICHARD
447	1447	1447	1447	1447	1447	LARSON, JON
1509	1509	1509	1509	1509	1509	HARTNETT, PAUL
		1545	1545	1545	1545	HURLEY, PATRICK
573	1573	1573	1573	1573	1573	JOSEPH, JUNE
999	1665	1665	1665	1665	1665	LEBLANC, EDGAR
1846	1846	1846	1846			MUNDIS, PAUL
				1850	1850	MURPHY, MATTHEW
1859	1859	1859	1859	1859	1859	NARDELLA, DANIEL
				2052	2052	SCHAVRIEN, WILLIAM
				2110	2110	SMART, LAWRENCE
				2185	2185	THEODORE, ERWIN
					2532	GANGON, JEFFREY

		BENASSI, HOWARD	WILLIAMSON, JOHN	DIMILLA, THOMAS	SILVA, JOSEPH	FRITZLER, FREDERIC	GAMBALE, ALFONSO	GATES, RICHARD	LARSON, JON	HARTNETT, PAUL	HURLEY, PATRICK	JOSEPH, JUNE	LEBLANC, EDGAR	NARDELLA, PAUL	MURPHY, MATTHEW	NARDELLA, DANIEL	SMART, LAWRENCE	LABELLE, PAIGE	GIDEON, SAUL			
	JAN	1083	1130	1315	1405		1435	1441	1447	1509	1545	1573	1665	1846		1859						
	FEB	1083	1130	1315			1435	1441	1447	1509	1545	1573	1665	1846		1859						
	MAR	1083	1130	1315		1442	1435	1441	1447	1509	1545	1573	1665	1846		1859	2110					
	APR	1083	1130			1422	1435	1441	1447	1509	1545	1573	1665	1846		1859	2110					
႘	MAY	1083	1130			1422	1435	1441	1447	1509	1545	1,573	1665	1846		1859	2110		3062			
L191.DOC	NOS S	1083	1130			1422	1435	1441	1447	1509	1545	1573	1665	° 1846	1850	1859	2110	3337				

	•	BENASSI, HOWARD	WILLIAMSON, JOJN	DIMILLA, THOMAS	FRITZLER, FREDERIC	GAMBALE, ALFONSO	GATES, RICHARD	LARSON, JON	HARTNETT, PAUL	HURLEY, PATRICK	JOSEPH, JUNE	LEBLANC, EDGAR	MUNDIS, PAUL	NARDELLA, DANIEL	NEWELL, SHAWN	SMART, LAWRENCE	LABELLE, PAIGE
	JUL	1083	1130	1315	1422	1435		1447	1509	1545	1573	1665	1846	1859		2110	3337
L291.DOC 1991	AUG	1083	1130			1435	1441	1447	1509	1545	1573	1665	1846	1859		2110	3337
	SEP	1083	1130			1435	1441	1447	1509	1545	1573	1665	1846	1859	2095		
	OCT	1083	1130			1435	1441	1447	1509		1573	1665	1846	1859	2095		
	NOV	1083	1130			1435	1441	1447	1509	1545	1573	1665	1846		•		
	DEC	1083	1130			1435	1441	1447	1509	1545	1573	1665	1846				
	JAN-92	1083	130			435	1441	1447	509		573	1665	1846				

FEB	1083	1130	1435	1441	1447	1509	1545	1573	1665	1846	1859	
MAR	1083	1130	1435	1441	1447	1509			1665	1846	1859	
APR	1130	1130		1441	1447				1665	1846		2095
MAY		1130		1441					1665	1846		
NOS NOS											20	
	MAY APR MAR	MAY APR MAR 1130 1083	MAY APR MAR 1130 1083 1130 1130	MAY APR MAR 1130 1083 1130 1130 1435	MAY APR MAR 1130 1083 1130 1130 1130 1435 1441 1441	MAY APR MAR 1130 1130 1083 1130 1130 1130 1435 1441 1441 1441	MAY APR MAR 1130 1083 1130 1130 1130 1435 1441 1441 1447 1447	MAY APR MAR 1130 1130 1083 1130 1130 1130 1435 1441 1441 1447 1447	MAY APR MAR 1130 1083 1130 1130 1130 1435 1441 1441 1447 1447	MAY APR MAR 1130 1130 1083 1130 1130 1130 1445 1447 1447 1509 1665 1665	MAY APR MAR 1130 1083 1130 1130 1130 1435 1441 1441 1447 1447 1509 1665 1665 1846 1846	JUN MAY APR MAR 1130 1130 1083 1130 1130 1130 1435 1441 1441 1447 1447 1509 1665 1665 1846 1846 1859

WILLIAMSON, JOHN GAMBALE, ALFONSO

GATES, RICHARD

LARSON, JON

HARTNETT, PAUL HURLEY, PATRICK

JOSEPH, JUNE LEBLANC, EDGAR

BENASSI, HOWARD

NEWELL, SHAWN SMART, LAWRENCE

2110

NARDELLA, DANIEL

MUNDIS, PAUL